

### 2.3 DZ 7 - AS Software Package

When a DZ 7 Tracing Table (or an HP plotter) is to be used only for batch plotting without a PLANICOMP, the DZ 7 - AS software package offers two application programs in addition to the GRAPH F1 library.

The SHEET PREPARATION (SHEET) program supports map sheet preparation and/or point plotting optionally also in the batch mode. Grid and map frame representation as well as coordinates annotation are similar to the C085 and C088 PLANICOMP programs. Points can be plotted with defined random symbols (optionally with number or elevation), and the point data can be read consecutively from several sources (files, peripheral equipment, also from the terminal). The size of grid crosses, margin annotations and point symbols as well as point numbers can be selected independently.

The DIGITAL PLOTTING program (C089) enables the plotting of previously stored map contents with a view to digital plotting. The map data has to be available in a device-independent graphical code in a file. Usually this code is generated by the acquisition program in the PLANICOMP (see section 2.4) or by PLANI-AS in an analog plotter (see section 2.5). The code for the GRAPH F1 subroutines has been documented /7/ so that self-programming users can, on the one hand, continue to write their own code generation programs and, on the other hand, may adapt to other graphical data bases.

The C089 program offers orientation and matching to existing map sheets by means of identical points, optionally also by affine transformation, and thus local entry in "old" maps, for example for map completion or map revision. During a program run, codes from several files can be plotted, i. e. information stored in several files can be combined or subsets (layers) of a single map stored in different files can be plotted.

So, in the DZ 7 - AS version, PLANIMAP supports pure batch plotting tasks like map sheet preparation or the plotting of map contents without a PLANICOMP. An HP 1000 computer equipped with a DZ 7, HP plotter or HP graphics terminal, or the computer of a Z2 ORTHUCOMP, for example, can be used. It is even possible to use a minimum HP 1000 configuration (e. g. the MICRO 26) specifically for this purpose.

### 2.4 Digital Plotting with PLANICOMP

The graphical plotting programs of the PLANICOMP still comprise the current programs for computer-supported plotting (B80, A81, A82 and C085 to C088) based on the GRAPH F1 library. Digital plotting programs are now also included, i. e. apart from the DZ 7 - AS plotting software package essentially the RECORD PLOT DATA digital mapping program (B83) for data acquisition and check-plotting.

RECORD PLOT DATA is started and controlled at the photogrammetric panel of the PLANICOMP just like all other B-priority programs. Numerical codes comprising up to 3 digits enable control of graphical measurement preparation and execution using menu information or free command entry. Help and overview functions provide information on the current mode and the plotting options at any time. For later "playback" output, orientation points can be measured and stored at the beginning. Real-time check-plotting with the DZ 7, an HP plotter or a graphics CRT terminal in parallel with graphical data acquisition is possible. The supported graphical elements are points, lines and areas.

Single point symbols can optionally be provided with additional information (e. g. point number or elevation) in fixed or freely selectable locations.

Composite lines can be defined in random sequence as vector polygons (with individually measured or incrementally determined polygon points), spline curves (according to Akima), and circle segments. Even within a composite line, switching is possible between the preselected standard line types (full, dashed, dash-dotted) and inserted symbols (constantly spaced or at measured polygon points). Parallel lines can be plotted in full or in part at optional distances of composite lines, and other symbol representations can be selected for the partner line.

Some frequently required special graphical elements have been implemented as areas or closed composite lines. Full circles can be plotted with the above line types. Closed polygonal areas provide area shading or area filling with symbols of the type available for single points in addition to the above-mentioned open traverse possibilities, and the measurement of several enclosed cut-out areas. Area shading or area symbols can also be used for houses which are plotted by rectangle completion after the measurement of three corners.

A special feature is the plotting of slope shadings by measuring the upper and lower slope edges. The edges themselves need not be plotted. The know-how described in /8/ has been implemented here.

The run-time parameters such as tracing pen, tracing speed, line type, spacings, symbols with symbol number, size rotation etc. can be updated at any time and separately for each element group. Finally it is possible to enter "remarks" in the graphical file in the form of numerical codes which do not have any executive effect by themselves but permit control specifications or object coding for other graphical data bases. A small number of possible combinations is shown in Fig. 1.

### 2.5 Digital Mapping with PLANI-AS

The functions of the RECORD PLOT DATA (B83) program for measuring and check-plotting graphical data described in the preceding section for the PLANICOMP are also available in an HP 1000 A version within the PLANI-AS program. Thus digital mapping is possible with the same numerical codes also with analog stereoplotters. Only program handling differs slightly from the PLANICOMP system because of the PLANI-AS controls (foot switch of the coordinates acquisition and transfer unit, terminal keyboard, and soft terminal keys, if available).

Support of digital mapping with analytical and analog stereoplotters is the key for the user to applying PLANIMAP as a general mapping system.

### 3. Interactive Mapping with the INTERGRAPH System

The terms "Interactive Graphic Systems" (IGS) and "Computer-Aided Design" (CAD) often crop up in the shop talk of surveying engineers today. The INTERGRAPH Corp. (previously M & S) plays a leading role in the field. The power of the INTERGRAPH systems is due mainly to about 1000 man/years of development work for the software, and to the realization that otherwise very powerful computer systems need improvement regarding the data transfer rate with disk files and graphics terminals if they are to be used for graphical data processing.

For cartographic and photogrammetric applications, another consideration is that the "Interactive Graphic Design System" (IGDS), the major INTERGRAPH product, is true three-dimensional in design in contrast to the products of many other manufacturers, and that the "Data Base Management and Retrieval Software" (DMRS) can also manage non-graphical information for future land information systems.

Thanks to the definition of an interface for the interchange of graphical data, the "Standard Interchange Format" (SIF), photogrammetric data can already be measured off-line and be further processed with an INTERGRAPH system.

However, an *i n t e r a c t i v e* photogrammetric workstation of the type implemented with the Zeiss E3 PLANICART described below offers many more possibilities.

### 3.1 Analog Plotter as INTERGRAPH Workstation

The IGDS system uses the DEC (Digital Equipment Corporation) PDP 11 and VAX 11 series computers and supports not only the usual computer periphery including graphical output units, but also one or several graphical workstations.

These workstations, which usually comprise a dual graphics CRT, a digitizing table and a terminal keyboard, are the real interactive workstation for entering two-dimensional graphical patterns and editing graphical data stored in "Design Files". For fast display build-up and fast execution of the entered commands and menu options, the workstation are equipped with Motorola 68000 microprocessors.

In the "Stereodigitizer Workstation" version, another microprocessor is used for coordinates acquisition with the analog plotter (both X, Y, Z model coordinates and optionally Y parallaxes), and for monitoring the additional control elements (a triple foot switch and a small key panel). The graphics CRT unit can be set up separately and should be set up as closely as possible to the plotter, and the displayed information can be panned in accordance with the following-mark movements and be zoomed in scale. The result is an one-man workstation for the interactive graphical plotting of photogrammetric stereomodels.

Basically any analog plotter equipped with encoders can be used as an interactive photogrammetric workstation (e. g. the Zeiss PLANIMAT, PLANICART and PLANITOP) without any particular modifications being required at the equipment.

### 3.2 Optical Superimposition with the E3 PLANICART

In Fall 1982, display superimposition with an optical interface was presented for the first time for the E3 PLANICART (Fig. 2). This option allows the line display of a high-resolution INTERGRAPH CRT unit to be mirrored into the left eyepiece of the PLANICART and to be superimposed with the stereo image. The 68000 microprocessor of the INTERGRAPH workstation continuously monitors the floating-mark movements in the tracking mode and moves the window in accordance with the graphical data in such a way that the line display on the screen is in coincidence with the stereo image.

This allows direct visual checking of the gathered graphical information for completeness and true identification by comparison with the air photo and immediate remeasurement and correction, if required. Graphical superimposition opens up interesting possibilities in particular in the map revision field.

### 3.3 The PLANICOMP as INTERGRAPH Workstation

The real-time connection of an analytical stereoplotter with a higher-level interactive graphical system is now presented for the first time in the world. In close cooperation with INTERGRAPH, software was developed for the Zeiss PLANICOMP that allows the data and control instructions required for full real-time operation to be interchanged (Fig. 3).

The PLANICOMP/INTERGRAPH interface is available as an option for every PLANICOMP (e. g. C 120, C 130) equipped with an HP 1000 A computer. It comprises an additional HP interface for asynchronous serial data transfer at a rate of 19 200 bits per second, special driver software developed by Zeiss, and an application program. Part of the driver software is installed as firmware in a Z80 microprocessor of the HP interface.

All PLANICOMP functions and applications supported by the installed hardware and software options remain fully operational. The same applies to the INTERGRAPH workstations. To activate PLANICOMP/INTERGRAPH communication, the RECORD INTERGRAPH DATA program (B76) has to be started in the PLANICOMP. Just as all the other B-level programs it can be terminated and restarted any time, and A-level programs or operating system functions can be activated in parallel.

The flexibility and power achieved by real-time connection are characterized by the following modes and functions:

- Tracking, i. e. transfer of the PLANICOMP floating-mark movements and display on the INTERGRAPH screen by a cursor with selectable tracking precision.
- Data Point, i. e. measurement of single points with the PLANICOMP and immediate transfer to the INTERGRAPH workstation.
- Stream Mode, i. e. automatic measurement of line sequences with selectable increments and Start/Stop control by the PLANICOMP operator.
- Reset, i. e. completion of a measured graphical element or object in the PLANICOMP.
- Tentative Point, i. e. transfer of the current floating-mark position in the PLANICOMP to the INTERGRAPH system and automatic positioning to the closed measured object for identification and editing.
- Move to, i. e. positioning of the PLANICOMP floating-mark to a point using coordinates and speed information specified by the INTERGRAPH workstation.
- Move along, i. e. specification of a profile for the PLANICOMP and automatic monitoring of manual profile measurement by the operator.
- Function button, i. e. emulation of selected INTERGRAPH function keys at the PLANICOMP panel.
- Bulk data, i. e. transfer of data files for further processing e. g. with background programs.

PLANICOMP/INTERGRAPH communication has been used in the USA in practical operation since Summer 1983.

### 3.4 Optical Superimposition with the PLANICOMP

Graphical superimposition as implemented for the PLANICART (see section 3.2) is, of course, also interesting for the PLANICOMP. The foundation has been laid with the real-time transfer of floating-mark movements and measurements from the PLANICOMP to the INTERGRAPH workstation described in the preceding section.

Therefore Zeiss has developed the optical superimposition interface also for the PLANICOMP. It is optionally available for all viewers equipped with zoom lenses. As with the PLANICART, the display of an additional INTERGRAPH CRT unit is mirrored into the left eyepiece after 2,5 x reduction.

## 4. Conclusions

With the new graphics options for the PLANICOMP, Zeiss has fulfilled today's user requirements in photogrammetric mapping.

Digital mapping with PLANIMAP and the described options enable direct graphical mapping. Compared to conventional and computer-supported drawing a productivity increase can be expected because of the higher working speed and the subsequent modification possibilities. Through the creation of "digital graphics", it is now possible to answer the growing demand for delivery of graphical data not only on map originals but also on data media. Compared to interactive graphical systems, instrument investment for digital mapping is lower, and decentralized organizations appear easy to implement.

In the long run, interactive mapping with interactive graphical systems such as the IGDS by INTERGRAPH will play an increasingly important role. It may even be the better alternative already now for special applications if the investment potential is adequate. The PLANICOMP/INTERGRAPH data interface and optical superimposition make it possible for the first time ever to use trend-setting analytical stereoplotters in the expedient real-time mode for interactive graphical mapping.

## REFERENCES

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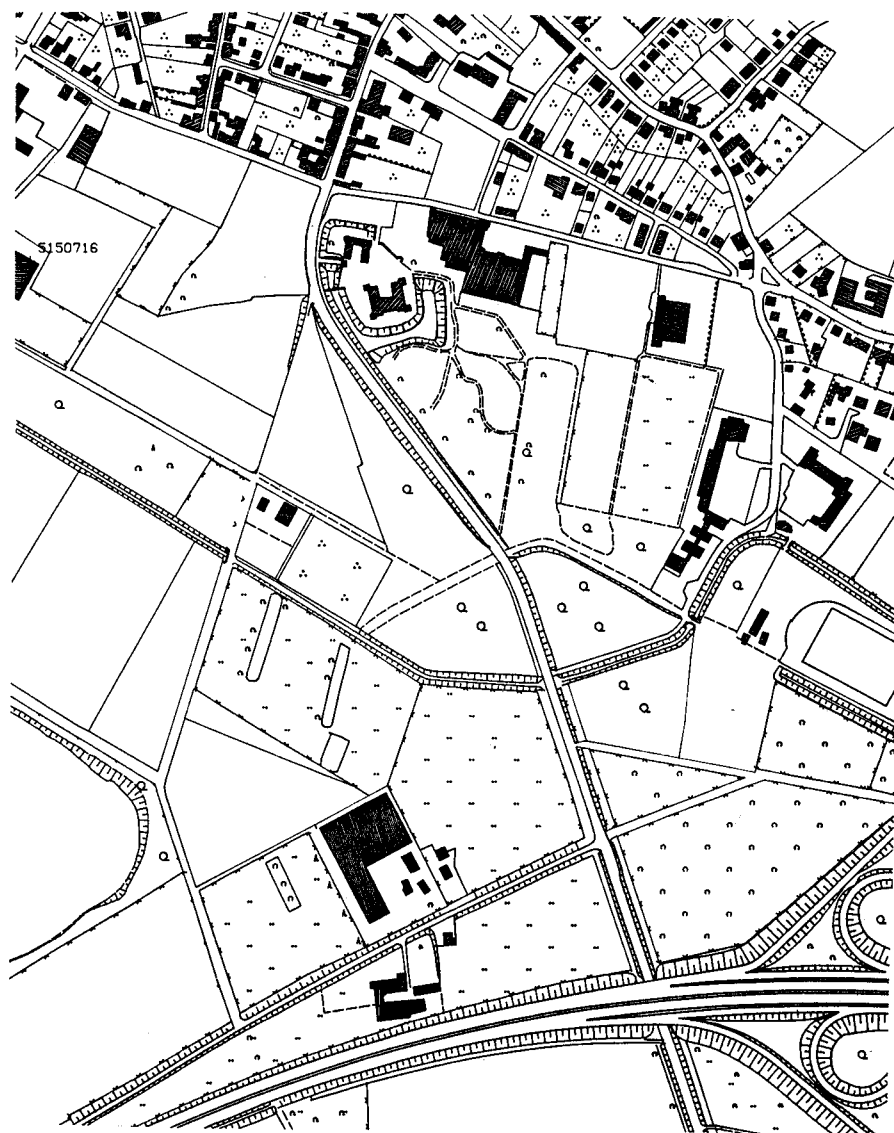


Fig. 1: Zeiss PLANIMAP Sample Graphical Representations

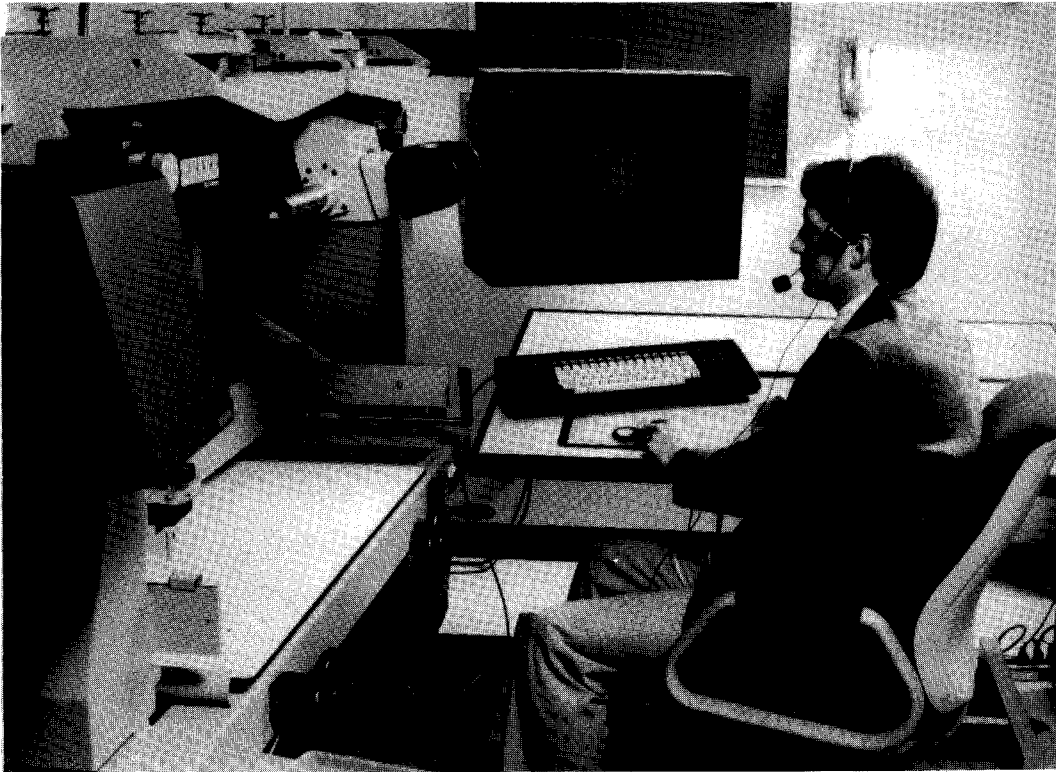


Fig. 2: ZEISS E3 Planicart with Display Superimposition connected to an Intergraph Stereodigitizer Workstation

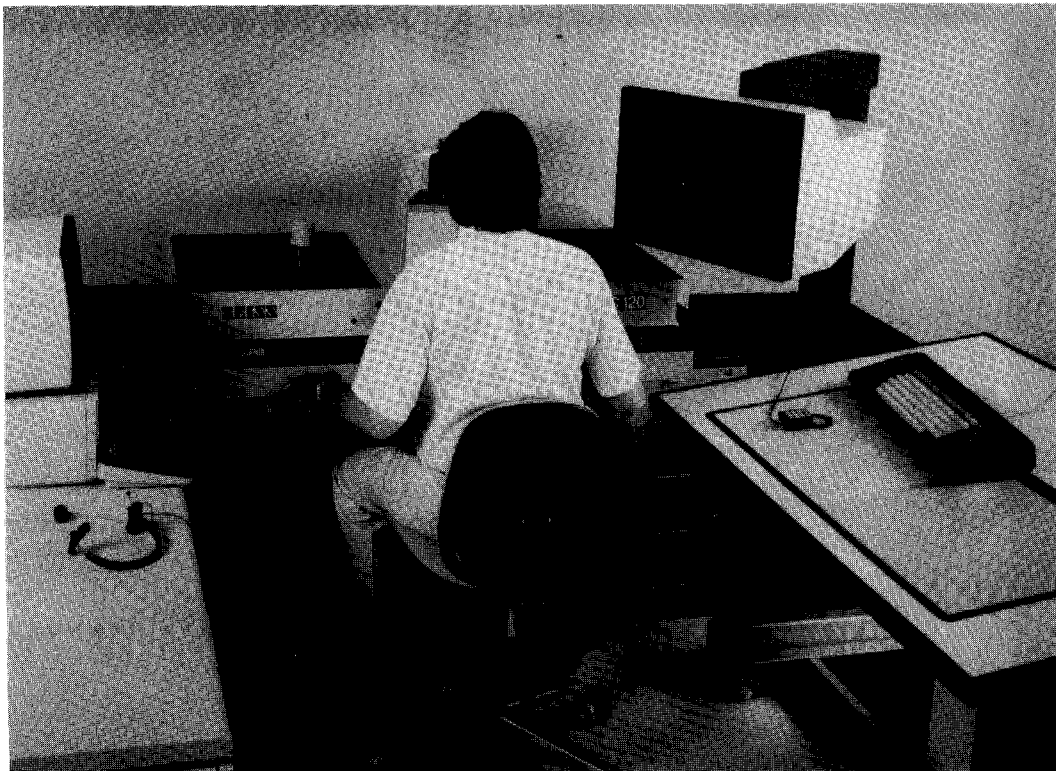


Fig. 3: ZEISS C120 Planicomp connected to an Intergraph Stereodigitizer Workstation

## Abstract

To facilitate graphical plotting, two features have been added to the Planicomp system family:

- Computer-supported direct plotting and digital storage of the graphical data, and
- Planicomp integration in the workstation of the interactive graphics system made by Intergraph.

Apart from the ZEISS DZ7 Digital Tracing Table, various HP graphics terminals and plotters can be used for on-line digital plotting. Salient features of the "New Graphics" are, to list only a few, freely definable symbols, straight, circular or curved lines of different types inclusive of symbol lines and parallel lines, shaded areas and slope shadings. Storage of the graphical data allows plotting to be repeated any time also in a different location using other scales and orientations. An enhanced version of the PLANI-AS program allows the "New Graphics" to be used also with analog plotters.

A completely different capability is offered when the Planicomp is connected to an Intergraph interactive graphics system. This system integration enables both real-time transfer of the points and lines measured with the Planicomp to the Intergraph workstation, and optical superimposition of the Intergraph screen with the Planicomp stereo image for direct visual checking.

## WEITERENTWICKELTE GRAPHIK ZUM PLANICOMP

### Zusammenfassung

Im Hinblick auf graphische Auswertungen wurde die Planicomp-Familie um zwei verschiedenartige Möglichkeiten erweitert:

- die rechnergestützte Direktkartierung mit gleichzeitiger digitaler Speicherung der graphischen Daten, sowie
- die Integration des Planicomp in den Arbeitsplatz des interaktiven, graphischen Systems der Firma Intergraph.

Für die digitale Direktkartierung können neben dem ZEISS-Digitalzeichentisch DZ7 auch verschiedene Plotter und Graphik-Terminals von HP verwendet werden. Die besonderen Leistungsmerkmale der "neuen Graphik" sind u.a. frei definierbare Symbole, Linien vom Typ Gerade, Kreisbogen, Kurve in verschiedenartiger Strichausführung einschließlich Symbol-Linien und Parallel-Linien, Flächen mit Flächenschraffur sowie Böschungs-Signaturen. Durch Abspeicherung der graphischen Daten wird es möglich, die Auszeichnung jederzeit auch an anderem Ort und mit unterschiedlichem Maßstab und Orientierung zu wiederholen. Mit einer erweiterten Version des PLANI-AS Programmes kann die "neue Graphik" auch an Analogauswertegeräten eingesetzt werden.

Eine grundsätzlich andere Möglichkeit bietet der Anschluß des Planicomp an ein interaktives graphisches System der Firma Intergraph. Die besonderen Merkmale einer solchen Systemkopplung sind einerseits Echtzeit-Übertragung der am Planicomp gemessenen Punkte und Linien zum Intergraph-Arbeitsplatz, andererseits die optische Überlagerung eines Intergraph-Bildschirmes mit einem Stereobild des Planicomps zur unmittelbaren Sichtkontrolle.

## PERFECTIONNEMENT DES PROGRAMMES GRAPHIQUES APPLIQUES AU PLANICOMP

### Résumé

Deux nouvelles méthodes de restitution graphique sont venues enrichir les possibilités du système de stéréo-restitution PLANICOMP;

- la cartographie directe assistée par ordinateur avec la mise en mémoire simultanée des données graphiques digitalisées, et
- l'intégration du PLANICOMP dans le système graphique interactif de la maison Intergraph.

La cartographie directe sur la base de données digitalisées peut avoir lieu sur la table traçante digitale DZ7 de Zeiss ou bien sur différents traceurs et terminaux graphiques de Hewlett Packard. Les caractéristiques de ces nouvelles méthodes de restitution graphique sont représentées entre autres par la possibilité de créer des symboles, par les différentes façons de tracer des lignes telles que des droites, des arcs de cercle et des courbes sans oublier les lignes de symboles et les lignes parallèles, et par la représentation des surfaces par des hachures ou par des signes conventionnels. La mise en mémoire des données graphiques permet de répéter le tracé à tout moment à un autre endroit à une échelle et avec une orientation différentes. Une version agrandie du programme PLANI-AS permet de mettre également à profit cette nouvelle possibilité de restitution graphique sur les appareils de restitution analogique.

Une possibilité tout à fait différente est fournie par le raccordement du PLANICOMP à un système graphique interactif de la maison Intergraph. Les principales caractéristiques d'une telle liaison sont d'une part le transfert en temps réel en direction de l'Intergraph des points et des lignes mesurés sur le PLANICOMP, et d'autre part la superposition optique des opérations visualisées sur l'écran de l'Intergraph avec l'image stéréoscopique produite par le PLANICOMP, procédé qui permet un contrôle visuel immédiat.

## PROGRAMAS GRAFICOS MAS AVANZADOS PARA EL PLANICOMP

### Resumen

Para facilitar la restitución gráfica, la familia de los Planicomp ha sido ampliada por dos posibilidades distintas:

- El trazado directo de mapas, apoyado por computadora con almacenamiento digital simultáneo de los datos gráficos, y
- la integración del Planicomp en el puesto de trabajo del sistema gráfico interactivo de la casa Intergraph.

Además de la mesa de dibujo digital DZ7 de Zeiss pueden utilizarse para el trazado digital de mapas en servicio on-line varios trazadores y terminales gráficos de la casa Hewlett-Packard. Son características especiales de estos nuevos programas gráficos: símbolos de definición libre, líneas tales como rectas, arcos de círculo y curvas, trazados en forma continua, con rayitas, puntos, etc., inclusive líneas de símbolos y líneas paralelas, áreas con su correspondiente rayado así como la representación de taludes. El almacenamiento de los datos gráficos hace factible repetir en cualquier momento el dibujo de los mismos en otro lugar, a escalas y con orientaciones distintas. Una versión ampliada del programa PLANI-AS permite emplear el nuevo programa gráfico también en restituidores analógicos.

Una posibilidad fundamentalmente distinta la ofrece la conexión del Planicomp a un sistema gráfico interactivo de la casa Intergraph. Las características particulares de un acoplamiento de sistemas de esta índole son por una parte la transferencia en tiempo real al puesto de trabajo de los puntos y líneas medidos en el Planicomp, y por otra la superposición de una pantalla Intergraph y de una imagen estereoscópica del Planicomp, para el control visual inmediato.

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